Notes on the Biology of North American Species of *Panurginus*[1]

(Hymenoptera: Andrenidae)

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The holarctic genus *Panurginus* is represented by 17 species in North America north of Mexico (Muesebeck *et al.*, 1951). The status of our knowledge concerning the biology of these taxa is limited to one eastern species *Panurginus potentillae* (Crawford) (Rozen, 1967). Rozen (1966, 1967 and 1971) has collected all published information on the biology and immature forms of the genus and also has synthesized and compared the biological information on all known panurgine bees. The present paper treats the mating behavior of *Panurginus occidentalis* (Crawford) and the biology of a second North American species *Panurginus atriceps* Cresson. The post-defecating larva of *P. atriceps* is described and figured.

Panurginus occidentalis (Crawford)

Observations on *P. occidentalis* were made on 2 April 1973 and 8–11 April 1974, 3.2 miles south of Pope Valley, Solano County, California. Sixteen mating pairs were observed between 1100 and 1500 Pacific Standard Time. Mating took place on the flower of *Limnanthes douglasii* Brown (Limnanthaceae), the pollen and nectar source of *P. occidentalis*. The male approached from above the female when she was on a *Limnanthes* flower. Most approaches were unsuccessful with both bees flying from the blossom. When initial approach and contact were successful, the male's fore legs held the female's pronotum, the middle legs wrapped around her propodeum and the hind legs grasped her second or third abdominal terga (Fig. 1). Then the female became motionless, and the male released the grip of his hind legs and held them outstreatched over the female's abdomen. He held his antennae forward over the female's head and moved them up and down between her antennae. If the female was still receptive, the male curled his abdomen down and under one side of the female's to copulate. The mating position was maintained from 35 to 95 seconds.

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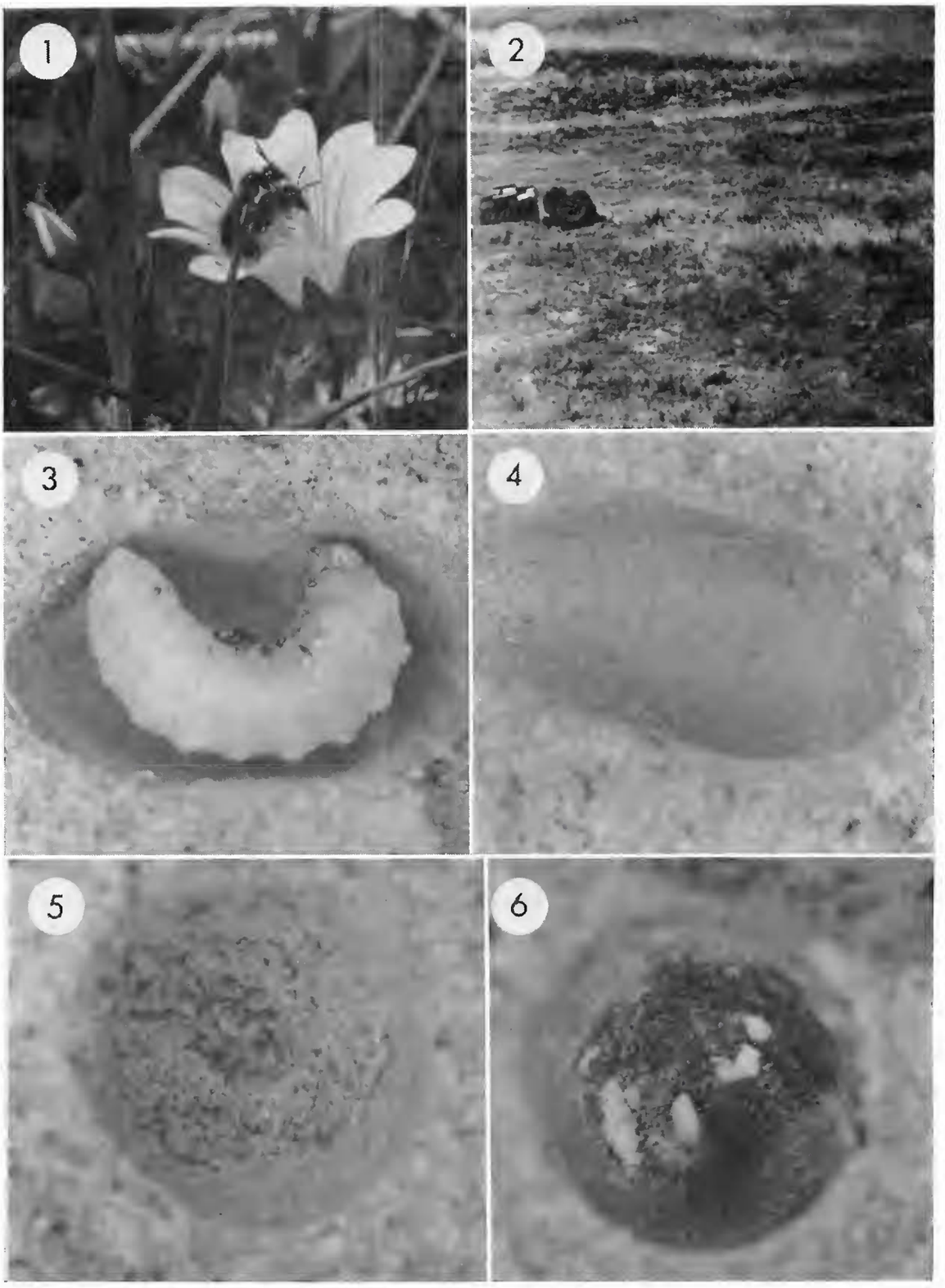


FIGS. 1–6. Fig. 1. Mating pair of *Panurginus occidentalis* (Crawford) in flower of *Limnanthes douglasii* Brown. Fig. 2. Nesting site of *Panurginus atriceps* Cresson. Fig. 3. Defecating larva of *Panurginus atriceps*. Fig. 4. Cell of *Panurginus atriceps*. Fig. 5. Cell cap of *Panurginus atriceps* showing spiral construction. Fig. 6. Fecal smear of *Panurginus atriceps* on posterior dorsal surface of cell.

PANURGINUS ATRICEPS (CRESSON)

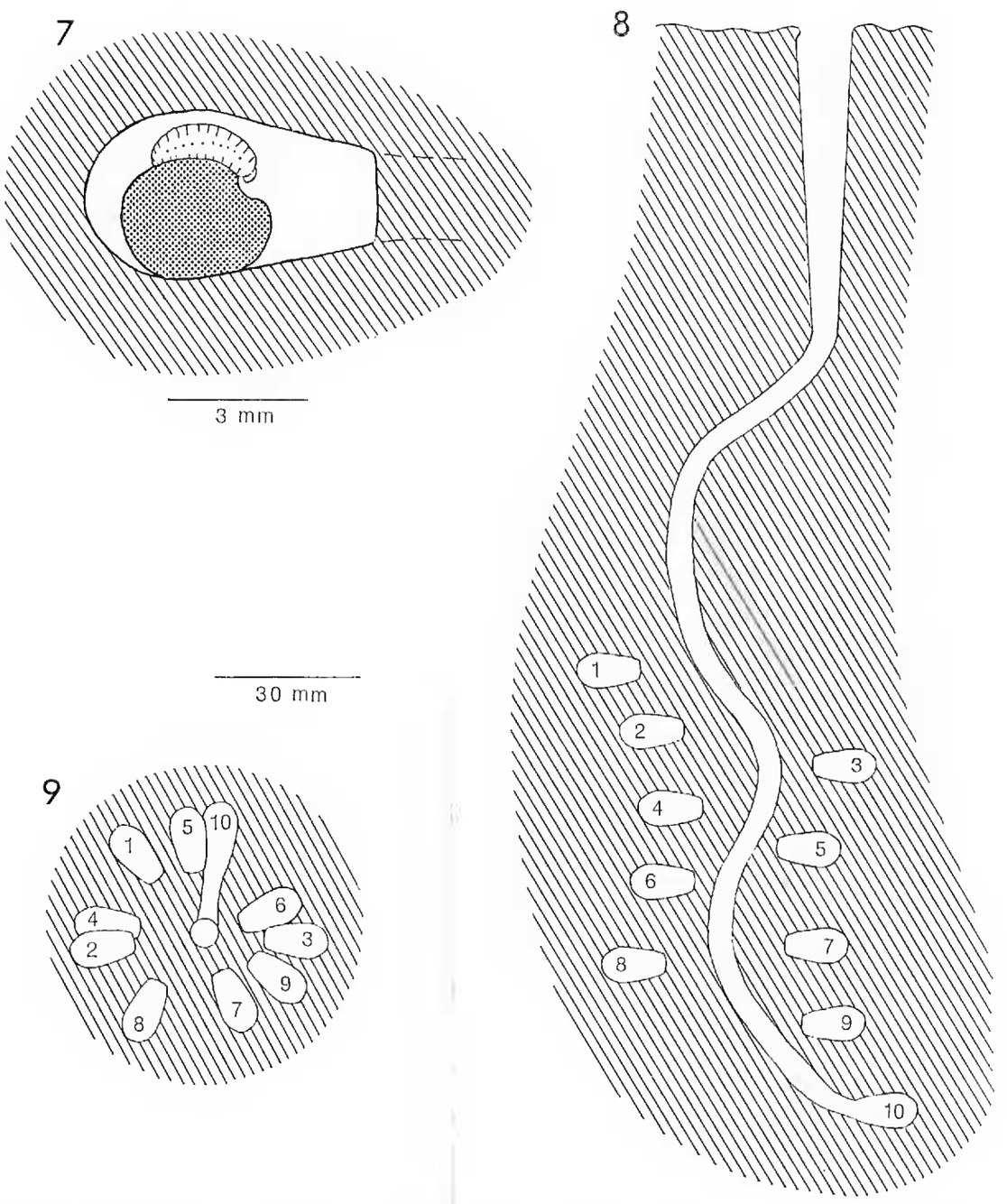
Nest Site—A nesting site of *P. atriceps* was discovered on 20 April 1973, 11 miles south of Dixon, Napa County, California. The surrounding area is referred to as "hog wallows," or vernal pools, a local habitat and a part of the Valley Grassland plant community. The community is a subtropical open treeless grassland characterized by winter rains averaging 15 to 50 cm and hot dry summers and with rich floral displays in wet springs (Munz and Keck, 1965). The site occupied a high mound of approximately 8 square meters (Fig. 2). The area was covered sparsely with vegetation and the soil surface was dry and hard packed. The vegetation consisted of scattered patches of *Bromus mollis* Linnaeus and individual plants of *Orthocarpus erianthus* Bentham. Other plants common in the immediate area were *Muilla maritima* (Torrey) and species of *Festuca, Hordeum, Deschampsia, Brodiaea, Sisyrinchium, Limnamthes, Plagiobothrys, Trifolium* and *Lasthenia.*

Soil temperatures between depths of 5 and 15 cm were measured between 1300 to 1600 hours during active nesting (27 April) and again during the hot period of the summer (25 August). Spring temperatures ranged from 26° to 22°C and summer from 32° to 29°C.

Adult Activity—The exact date of appearance was not determined. Males were at the nest site and attempting to mate with females when the site was discovered. Males were not observed approaching females collecting pollen or nectar. Pollen laden females landed on the bare ground near one of the numerous cracks in the soil and disappeared into a crack. Five nest entrances were marked. Four nests were excavated on 4 May and the fifth on 8 June 1973. Females visited a patch of *Downingia bella* Hoover or *D. cuspidata* (Green) located about 10 to 15 meters from the nest site in one of the low, wet areas of the vernal pools. *Downingia* began blooming on 12 April and all flowers were gone by 4 May 1973. It appears that the adult activity of *P. atriceps* was confined to this 4 week period, since no adult bees were observed on or after 4 May 1973.

Pollen and nectar collecting behavior were not observed, but female bees were collected only from *Downingia* flowers and stored provisions contained only *Downingia* pollen grains.

Nest Architecture—The entrances to the five nests were located in or at the bottom of cracks in the soil (Fig. 8). The cracks were generally 5 to 10 mm wide and varied in depth from 20 to 80 mm but nest entrances were found only in cracks 20 to 30 mm deep. Use of soil cracks for the "initial" portion of the burrow was probably because



FIGS. 7–9. Fig. 7. Cell, pollen-nectar store and early instar larva of *Panurginus atriceps* Cresson. Fig. 8. Diagram of one nest excavated indicating position of cells. Fig. 9. Diagram of same nest showing spiral arrangement of cells (numbers in Figs. 8, 9 indicate same cells).

the compacted, brick-like surface layer of the soil could not be worked by the bee. The main burrow was 3.0 mm in diameter and spiraled irregularly downward to a maximal depth of 110 mm (Fig. 8). Open lateral burrows were found in 3 of the nests excavated and were located at the bottom of the main burrow and extended at a right angle 4 to 8 mm from the burrow. The open laterals were smaller in diameter (2.0 to 2.5 mm) than the main burrow and terminated in unfinished

or partially provisioned cells (Figs. 8, 9). After cell closure the laterals were filled with soil and were indistinguishable from the surrounding soil. Both burrows were unlined.

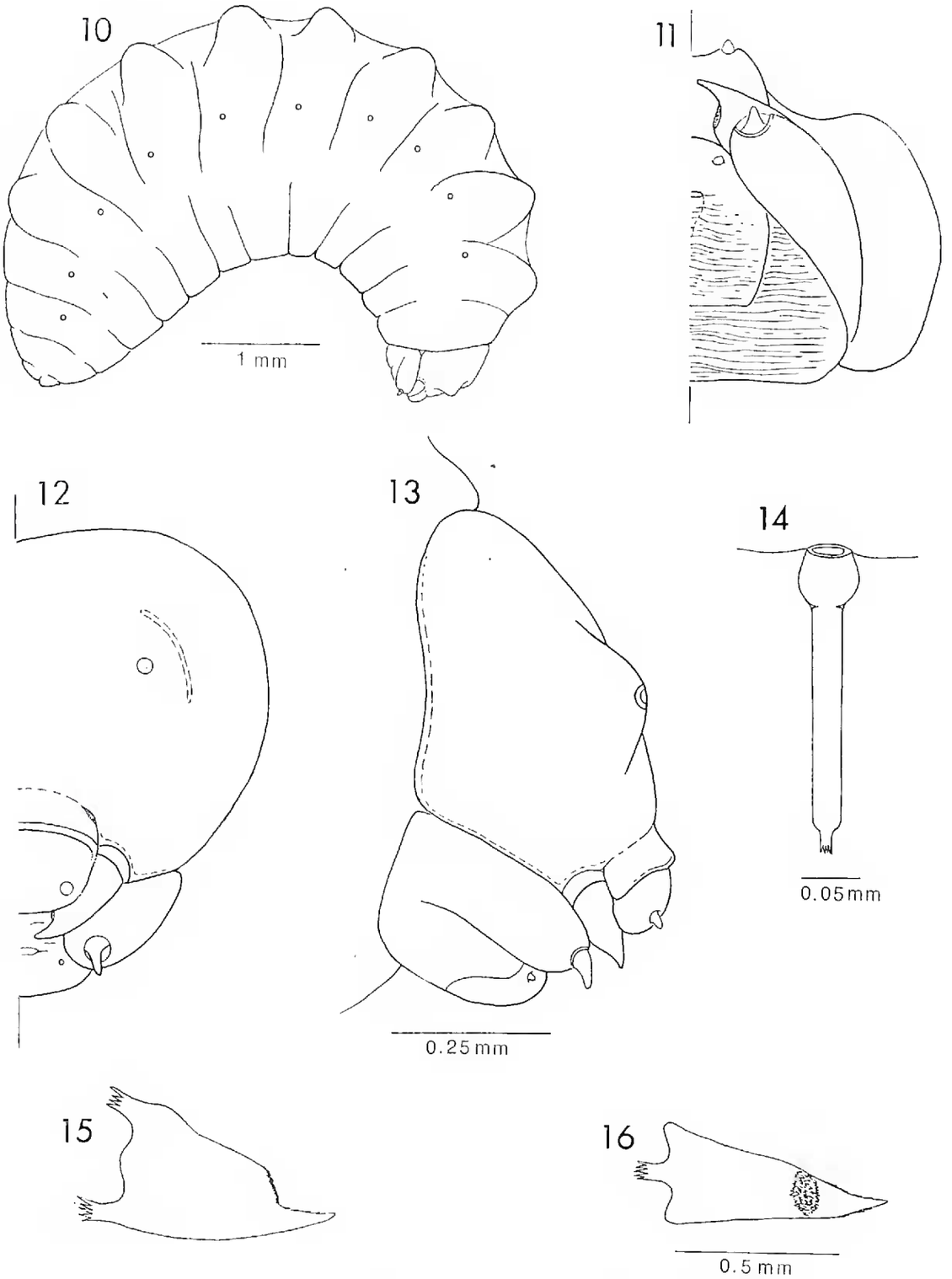
Individual cells were horizontal and radiated from the main burrow in any direction (Figs. 4, 7, 9). The cells were spheroid in shape with a mean length of 6.12 ± 0.09 mm, maximal diameter of 3.24 ± 0.1 mm, and with a neck diameter of 2.09 ± 0.06 mm (14 intact cells measured) (Fig. 7). Each cell was lined with a shiny, waterproof, wax-like layer. Nests examined on 4 May contained 10, 8, 7 and 6 cells and the nest of 8 June, 7 cells. The cell was completed with a spiral cap formed by several concentric rings of loose granular soil particles and lacking the waxy lining (Fig. 5). The inner 1 to 1.5 mm of the cap was removed easily; however, the soil plugging beyond that point was tightly packed and not easily loosened.

Provisions—The nearly spherical pollen-nectar store was positioned in the posterior portion of the cell (Fig. 7). Two intact stores were 2.5 and 3.0 mm in length (diameter) and 2.0 and 2.2 mm high. They were light yellow and relatively dry with no moist areas. Pollen from 14 cells proved to be entirely *Downingia.*

Immature Habits—The position of the egg on the pollen-nectar store was not observed but, from the position of an early-instar larvae (Fig. 7), it presumably was on the dorsal surface of the mass just off center with its long axis paralleling the length of the cell. It was impossible to tell if one or both ends of the egg touched or were embedded in the surface of the mass. The young larva feeding on the store formed a concave depression on the dorsal surface (Fig. 7). After consuming the pollen-nectar store, the flaccid pre-defecating larva rested on its dorsum with its head in the anterior portion of the cell.

Fourteen larvae obtained on 4 May and maintained in the laboratory defecated from 6 May to 11 May. The yellow-brown fecal pellets were extruded singly and since the larvae were not in normal cells, the pellets remained attached forming either a long chain or a pile on the ventral surface of the larvae (Fig. 3). Pellets ranged from 0.6 to 0.75 mm long and 0.3 to 0.45 mm wide. Defecation terminated with a moist droplet of whitish-grey material which dried on the tip of the abdomen. The feces, when produced in a soil cell, were smeared onto the posterodorsal surface of the cell to form a brown-black circular spot about 2.5 mm in diameter. The surface of the smear was streaked with the whitish-grey material (Fig. 6).

Ten of the larvae were maintained at 21 ± 4°C and 75% R.H.



FIGS. 10–16. Fig. 10. Post-defecating larva of *Panurginus atriceps* Cresson. Figs. 11, 12, 13. Head capsule of *Panurginus atriceps*, ventral, frontal and lateral views. Fig. 14. Spiracle of *Panurginus atriceps*. Figs. 15, 16. Mandible of *Panurginus atriceps*, dorsal and inner views.

throughout the remainder of the summer and fall. From November through March the temperature was lowered to $5 \pm 4°C$ with the same R.H. and in April was returned to 21°C and 75% R.H. Nevertheless, they had failed to pupate by June 1974 and were preserved at that time.

Comparison of Nesting Biology—The nesting biology of *P. atriceps* is similar to *P. potentillae* (Rozen, 1967) with the following exception. Since *P. atriceps* used soil cracks for the initial section of the "burrow," no tumulus was found, and I could not see if the burrow was plugged with soil as found in certain nests of *P. potentillae*. The waxy cell lining of the *P. atriceps* cell could not be peeled away from the soil surface. The cells were larger and deeper in the soil than those of *P. potentillae* and the burrow diameter was greater. The pollen-nectar store was approximately the same size and shape as that of *P. potentillae*.

Post-defecating Larva—Body: Color white; shallowly C-shaped; greatest length 4.5 mm, greatest height 2.0 mm (Figs. 3, 10); spicules present, not pigmented, more concentrated on dorsal surface near dorsal tubercles. Dorsal tubercles present, 3 pairs thoracic and 5 pairs abdominal, others reduced; thoracic and 1st abdominal largest, others progressively smaller. Last abdominal segment (10th) smallest; without tubercles; anal opening a transverse slit, dorsad of midline. Spiracles small; atrium spherical, walls smooth; rim slightly elevated, rim diameter 0.03 to 0.04 mm; colar present; subatrium elongate (Fig. 14).

Head capsule (Figs. 11, 12, 13): Width 0.65 to 0.75 mm, height 0.70 to 0.80 mm. Mandibles, maxillary palpi, labial tubercles pigmented, labial palpi faintly pigmented, antennae and parietal bands unpigmented. Vertex only slightly produced above antennal prominence; epistomal ridge (suture) weakly developed; clypeus protruding forward with distinct labroclypeal suture and ridge; labral tubercles directed ventrally, apex acute (Fig. 13); maxillary palpi large, protruding 0.05 mm from maxilla, apex curved ventrally; labial palpi small; salivary opening circular; prementum distinct from postmentum; pleurostomal thickening weak; hypostomal ridge well developed; posterior tentorial pit very evident; anterior tentorial pit weakly evident; posterior tentorial arms large, acutely triangular; anterior tentorial arms smaller; posterior thickening of head capsule well developed laterally, weak dorsally. Mandible (Figs. 15 and 16) slender, apex acute, inner upper and lower apical surfaces with minute teeth; cusp produced, minutely toothed; apex and toothed surfaces darkly pigmented.

Panurginus atriceps agrees with Rozen's (1966) generic description of *Panurginus* larvae. It is easily separated from *P. potentillae* and *P. melanocephalus* (Cockerell) by its smaller size and distinct prementum. *Panurginus atriceps* is similar to the species described and figured in Rozen as Species A.

The common method of clearing the head capsule (10% KOH) caused the epicuticle to peel away; therefore, I used Essig's Aphid Fluid as described by Torchio and Torchio (1975) for a mild clearing agent. Essig's Aphid Fluid was also used to clear the body integument. The 10 post-defecating larvae used in the figures and description had progressed into the final molt and, except for the heavily sclerotic arms, their tentoria were not intact. The spicules were noticeable

only on cleared integument mounted and observed with a compound, light microscope (400 ×).

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As the author states in his summary (p. 344) this is primarily a descriptive work, over 225 pages being devoted to an extensively annotated taxonomic list. The remainder of the text is devoted to discussions of the history of lepidopterology in Fiji and adjacent islands, the natural history of Fiji, and an analysis of the biogeographic relationships of the macrolepidopteran fauna.—Editor.